An examination of adolescent dental health by urban and Appalachian status

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Abstract

The objectives of this study were to examine the association between parent-rated dental health and urban vs. Appalachian residence among adolescent males, and to explore factors that may contribute to differences in dental health by region. Adolescent males from urban and Appalachian Ohio (n = 1220, age 11-16 years) completed a food frequency questionnaire to quantify fruit, vegetable, and sugar intake, and a self-administered survey to measure past 30-day tobacco use. Parents or guardians reported when the participants had last visited the dentist and rated their dental health. Analyses were conducted to determine the associations between fair/poor dental health and Appalachian residence, differences in poor dental health risk factors by Appalachia residence, and whether the effect of Appalachia residence on dental health was attenuated after controlling for risk factors. Boys in Appalachia had a marginally higher prevalence of fair/poor dental health compared to urban boys. Boys from Appalachia were more likely to have used tobacco in the past and consumed fewer fruit and vegetables, more added sugar and more sugary beverages than urban boys. The association between fair/poor dental health and residence was attenuated in the adjusted model. Our findings suggest that some of the disparities in dental health observed between people living in Appalachian and urban areas may be related to behavioral factors like tobacco use and diet. We provide support for behavioral interventions to these issues in the Appalachian community.

Introduction

Good dental health, which is the absence of dental decay and excessive tooth loss, [1] is essential to good general health. Many health issues in other areas of the body, for example the heart, are associated with poor dental health.[1] One common condition that leads to poor dental health is dental cavities, which is largely a preventable health issue in children.[2]

While good dental health should be considered a priority in order to promote good general health to all ages of the population, several children and adults are not meeting this goal. From 2011 through 2014, 18.6% of children (5-19 years) and 31.6% of adults (20-44 years) had untreated dental caries.[3] Moreover, in 2015, 84.7% of children (2-17 years) visited a dental office in the previous year and among adults (18-64 years), only 64.0% had a visit.[3]

Good dental health is important for children and adolescents because these are the years in which health behaviors are formed. Unfortunately, children comprise a large percentage of the population with poor oral and dental health, which can affect their health in the future. For example, cavities are one of the most common childhood chronic conditions.[4] Approximately 1 in 5 children (age 5-11 years) and 1 in 7 of adolescents (age 12-19 years) have at least one untreated decayed tooth.[4]

Risk Factors Affecting Poor Dental Health

There are a variety of factors that affect overall dental health status. Income plays a role in the development of cavities, with 5- to 9-year-olds from low-income backgrounds being more than twice as likely to have cavities compared to children from higher income backgrounds (25% vs. 11%, respectively).[4] Other determinants, like insurance quality and

type, also impact dental health.[5] For example, in a study focused on Harlem residents, patients who were uninsured or underinsured believed they did not receive proper care, which led to teeth extractions and inadequate coverage.[6]

Diet plays a major role in oral and dental health, especially related to tooth decay. For example, the association between high sugar consumption and tooth decay has been well known for quite some time.[5] Moreover, the World Health Organization (WHO) reported a positive association between increased consumption of free sugars, monosaccharides, and disaccharides that are added to food and sugars naturally present in honey, syrups, and juices, and the increased prevalence of dental caries across all ages.[7]

Tobacco use also leads to dental health issues. In the retrospective 8-year study by Ditmver et al., use of all forms of tobacco among adolescents was associated with an increased prevalence of dental caries.[8] And among adults aged 18-64 in the United States, 82% of never smokers were found to have very good or good dental health, while the percentages decreased between former smoker (74.4%) and current smoker (58.5%).[9]

Protective Factors Preventing Poor Dental Health

While we know the factors that influence dental health, there is still a large percentage of the population that does not receive the proper preventative measures. Considering that a major cause of dental caries is dietary consumption of sugar, there are many preventative measures to combat this risk. For example, manual or powered tooth brushing and flossing help to sustain and improve dental health.[10] Moreover, lowering the consumption of sugar-rich foods, fluoridating water, and providing dental programs in schools are possible options and interventions for health improvement.[11] Furthermore,

another preventative measures to curb possible dental health issues is dental sealants for children, which are protective coatings covering the back teeth.[2]

Barriers to Receiving Dental Care

Low-income individuals face unique challenges to receiving dental care that are primarily related to Medicaid coverage. Many dental professionals do not accept Medicaid.[12] This is a particular problem for children who need pediatric dental care. Specifically in Ohio, Medicaid covers 40% of all children.[13] A study conducted in Illinois found that only about one-third of children who were enrolled in Medicaid actually received dental care, and it was even lower (about one-fourth) among children in rural areas.[12] The same study also found that 51% of children utilized Medicaid for dental care at age 4, but this rate decreased to 28% during the teenage years.[12] Squillace reported that 71% of Missouri dentists fall under this category of not providing dental care to patients who have Medicaid coverage. Additionally, 38% of the Missouri counties do not have a dentist that will accept Medicaid/CHIP.[14]

In addition to the challenges that having Medicaid brings to finding care, other major barriers, such as cost, distance, and lack of public transportation, are other reasons that explain poor dental health in low-income communities.[15] In one study, over half of current smokers and over one third of former and never smokers did not visit a dentist in the past 6 months because of the high treatment costs or lack of insurance.[9]

Rural vs. Urban Differences in Dental Health Status

Rural residents face many barriers to receiving dental care and have worse dental health than their urban counterparts on average. One study reported that rural children were more likely to lack dental insurance (41.1% vs.34.7%) and less likely to visit the

dentist in the past year (69.9% vs. 73.6%) than urban children.[16] In another study, Kentucky urban county residents were more likely to have dental insurance compared to rural county residents.[17] Moreover, participants in an urban Kentucky county were more likely to visit the dentist and less likely to see the dentist for emergency situations compared to rural participants.[17] The root cause of this lack of care is that there are fewer dentists in rural areas. For example, a study conducted in Illinois reported that there were only three practicing pediatric dentists in the 74 rural counties that were observed.[12]

Another barrier to accessing proper dental care is the fear some people have of visiting a dentist, which appears to be greater in rural areas. A study conducted in West Virginia, which is an entirely Appalachian state with known dental health disparities, reported a high prevalence (47.1%) of dental fear. Moreover, a greater prevalence of dental fear was associated with having delayed dental care appointments.[18]

Not only are there barriers to receiving proper dental care, but also the emphasis on proper dental care may be less of a priority in rural and Appalachian communities. In West Virginian communities, the need for good dental health was ranked as the lowest priority out of other health issues, such as obesity, cancer, and alcohol and drug usage.[19]

Current Study

Although research has examined the overall health differences between urban and Appalachian populations, including among adolescents, few studies have directly compared the two populations with respect to dental health status. It is important to detect whether there are differences by region in order to address any disparities between the two adolescent populations. In order to fill in the research gaps regarding adolescent dental health, we analyzed data from a study of urban and Appalachian adolescents to identify

associations between adolescent dental health and factors such as Appalachian vs. urban residence, diet, and tobacco use. The primary objective was to examine the association between parent-/guardian-rated dental health and urban vs. Appalachia residence. The secondary objective was to explore how other factors related to dental health, including number of dental visits, race/ethnicity, tobacco use, diet factors, and income differ between Appalachian and urban adolescents in an attempt to explain dental health status differences between the two groups.

Methods

Participants

This study used baseline data from a prospective cohort study that was designed to examine factors associated with initiation of smokeless tobacco and cigarettes among urban and Appalachian male youth in Ohio. The participants (N=1,220) were adolescent males between 11 and 16 years of age who resided in one urban county or one of nine Appalachian counties. Exclusion criteria included any hearing or vision impairments or the inability to read or speak English because participants were administered audio and written surveys.

Participants were recruited through probability address-based sampling (ABS) and non-probability community-based sampling. ABS involved sampling addresses from the United States Postal Service's address list. Each selected household was sent a recruitment packet to determine if there was an eligible adolescent male in the household. With non-probability sampling, strategies to recruit eligible adolescent boys included advertising at community events, snowball sampling, and advertising in various media outlets.

Interviewers called potentially eligible households to determine final eligibility and interest in the study. Then, a baseline interview was scheduled.

Procedures

The Institutional Review Board at The Ohio State University approved all study procedures. Trained interviewers, residing in the same region as the participant, obtained informed permission and assent from parents/guardians and adolescent participants, respectively. Then, the baseline survey was administered. The survey was interviewer-administered for non-sensitive questions, such as demographics, and it was audio-administered for sensitive survey questions, such as smoking status. Audio-administered questions were asked using a computer with a headset and without interviewer assistance.

After the baseline survey, the Block Kids 2004 Food Frequency Questionnaire (FFQ) from NutritionQuest was administered.[20] This FFQ measures intake of fruits, vegetables, meats, dairy, and sugars, among other diet components.

Parents completed a self-administered questionnaire to provide information on health of the participants. The questionnaire asked about perceived dental health and last dental visit. Parents also reported their child's tobacco use behaviors and household socioeconomic status.

Measures

Primary outcome. The primary outcome variable of this study was parent-reported dental health of the participants. Parents/guardians responded to the question, "How would you describe the condition of your son's teeth: excellent, very good, good, fair, or poor?" Responses were dichotomized as excellent/very good/good or fair/poor.

Dental visits. Parents/guardians were also asked about dental visits with the item, "About how long has it been since your son visited a dentist? Include all types of dentists, such as orthodontists, oral surgeons, and all other dental specialists, as well as dental hygienists." The options included 6 months or less; more than 6 months but not more than 1 year ago; more than 1 year, but not more than 2 years ago; more than 2 years, but not more than 3 years ago; more than 3 years, but not more than 5 years ago; more than 5 years ago; or never has been. Responses were dichotomized as less than a year and more than a year.

Dietary variables. From the Block Kids 2004 FFQ, dietary questions were asked and used to create "total fruit, cups," "total vegetables, cups," "added sugars, teaspoon equivalents" and "average daily grams of sugary beverages." The FFQ listed different types of foods and drinks and then asked the participant about frequency and quantity of consumption. For each food, the FFQ asked two questions of the participants. The first question concerned how many days in the last week did they eat the food (response options: *None, 1 day, 2 days, 3-4 days, 5-6 days, Every day*.) The second question was "How much [of the food did you eat] in one day" (response options differed depending on the food item). Pictures of portion sizes were provided to participants for reference. Dietary analyses (e.g., grams of added sugar, grams of sugary sweetened beverages, and servings of fruits and vegetables) were available immediately after each survey was completed. For the analysis, fruit and vegetables variables were combined to create the "total fruit and vegetables, cups."

Tobacco variables. Tobacco questions were asked in the baseline survey and used to create "current tobacco use" (i.e., past 30-day use) variables. Separate questions were asked about cigarettes, smokeless tobacco, e-cigarettes, pipes, cigar products, hookah, bidis

and kreteks. Answers were combined to represent any current use of a tobacco product (yes/no).

Demographic variables. Participants self-reported their birthdate (used to calculate age) and race/ethnicity. Appalachian vs. urban status was based on where the participant lived. Socioeconomic status of the household was based on the parent/guardian response to a question about household income; the options included < $15,000, $15,000 but less than $25,000, $25,000 but less than $35,000, $35,00 but less than $50,000 and $50,000 or more. The responses were dichotomized into low (< $50,000) vs. moderate or high ($50,000 or more) income.

Statistical Analysis

The objectives of the analyses were to determine urban vs. Appalachian associations with parent-reported dental health of the adolescent boys and to identify behavioral risk factor associations with urban vs. Appalachian status. First, descriptive statistics overall and by region (urban vs. Appalachia) were calculated. Age, race/ethnicity, dental visits, tobacco use, and diet were examined descriptively. Second, survey adjusted logistic regression and linear regression models were fit to determine the associations between urban vs. rural status and the following variables: dental visits, sociodemographic variables, smoking status, and diet variables. Third, a logistic regression model was fit to the data, with the outcome parent/guardian-rated dental health and the primary independent variable urban vs. rural status. Finally, dental visits within the past year, tobacco use, diet, age, race/ethnicity, income, and dietary sugar intake, were incorporated into the model as covariates.

An alpha level of 0.05 was used for statistical significance. SAS version 9.4 (Cary, NC) was used to analyze the data. All analyses were weighted and accounted for the sampling design.

Results

Summary Statistics

As reported previously, this study included 1,220 participants, where 708 were from urban Franklin County and 512 were from one of the nine rural Appalachian counties. ABS was used to recruit 991 participants, whereas the remaining 229 were recruited through convenience sampling.[21] Participants who were missing parent-reported dental data were excluded from the analysis (n = 22). Most of the missing data was due to parents not taking the survey, while one participant responded "Don't Know" for both perceived dental health and dental visits. The average age was 13.9 years. Regarding race/ethnicity, 68.2% identified as non-Hispanic White and 16.2% identified as non-Hispanic Black.

Urban vs. Appalachian Region and Dental Health

There was a trend towards significance between parent/guardian-rated dental health and region (Table 1). More participants residing in urban areas tended to exhibit excellent to good dental health than in Appalachia (93.7% vs. 90.3%, p = 0.0652). The percent of Franklin County participants who visited a dentist within the past year was slightly higher than the percent in Appalachian (91.3% vs. 90.0%). However, the difference was not statistically significant (p = 0.3).

Results for tobacco use showed a significant difference by region. Franklin County participants' past 30-day tobacco use was lower than Appalachian past 30-day tobacco use (3.8% vs. 8.0%, p = 0.0061). There were also significant differences for all diet variables by

region. Franklin County residents consumed more fruits and vegetables than Appalachian residents (3.1 ± 0.1 vs. 2.6 ± 0.1, p = 0.0010). Franklin County residents consumed less added sugar (14.6 ± 0.5) and grams of sugary beverages (276.8, ± 13.6) than Appalachian residents (added sugar consumption = 18.3 ± 0.6 and grams of sugary beverages = 404.6 ± 19.8, both p < 0.0001).

When testing for parent-reported dental health and region only, boys in Appalachia had a marginally higher percentage of fair/poor dental health (unadjusted OR = 1.61; 95% CI 0.97, 2.67) (Table 2). In Models 2-5, the ORs for Appalachian vs. urban ranged from 1.70-1.79. However, in Model 6 that controls for dental and behavioral risk factors, including two diet measures (fruit and vegetable intake and added sugar intake), the OR for Appalachian vs. urban decreased toward the null and the 95% CI widened to a lower bound that is far from 1.0 (adjusted OR = 1.58; 95% CI: 0.86-2.90) (Table 2).

Discussion

Our primary goal was to examine whether Appalachian adolescents had worse dental health than urban adolescents. The findings suggest that behavioral and dental health risk factors associated with Appalachian communities, such as diet and tobacco use, can help explain differences in adolescent dental health between urban and Appalachian regions. Regarding diet, Appalachian adolescents consumed less total fruit and vegetables, but more added sugar and sugary beverages. For tobacco, past 30-day use was higher among adolescents in Appalachia. Previous dental visit was not associated with differences in adolescent dental health by geographic region.

The primary objective examining the association between parent-reported dental health and geographic residence demonstrated that Appalachian participants had a

marginally lower percentage of good dental health than their urban counterparts. Previous research has reported better dental health among urban adolescents.[12] Yet our findings trended toward statistical significance, but did not reach the threshold. Possible reasons could be potential bias from the parent-reported dental health stating that their child's dental health was better than they believe or what it actually is. Another explanation could be that the Appalachian parents were less likely to understand what proper dental health entails, and thus could qualify many characteristics along the spectrum as less likely to be poor.

Our secondary objective was to determine if behavioral and dental health risk factors differed between urban and Appalachian adolescents. The most important findings in this study were that diet and past 30-day tobacco use appear to be key contributors to marginally higher rates of fair/poor dental health among Appalachian adolescent males. The three diet factors could explain why adolescent males have marginally poorer dental health. Appalachian males consumed fewer total fruit and vegetables, more added sugar, and more added sugar from sugary beverages than their urban counterparts. When we controlled for two of the diet variables, we found that the trend toward significance disappeared. In Model 6, the odds ratio was attenuated toward the null, showing that these dietary variables explained some of the differences between adolescent dental health and the two regions.

Appalachian males were more likely to use any tobacco product in the past 30 days. In 2017, past 30-day tobacco use among adolescents aged 12-17 in non-metro areas was 7.8%, while it was 3.8% in large metro areas and 5.6% in small metro areas.[22] Moreover, rural adolescents were more likely to become daily smokers than urban and suburban

adolescents.[23] With greater tobacco usage in Appalachian areas, this is consistent with previous studies stating tobacco use is associated with increased prevalence in dental caries and poorer overall dental health.[8,9]

Because access to dental care is a major barrier to proper dental health, dental visits in the last year were analyzed. Our findings showed that there was no difference in frequency of dental visits between rural and urban boys. Interestingly, previous research has found that rural residents were less likely to visit the dentist in the past year.[16] An explanation for this difference could be because of the participants being in Ohio and not fully being representative of all rural areas in the country. Because Appalachian residents in Ohio could be closer to bigger Ohio cities with pediatric dentists, distance might not be as major of a factor for this population. Another possible explanation could be Ohio's Medicaid expansion in 2013. From pre-expansion in 2012 to post-expansion in 2015, uninsured Ohio children decreased in half (4.6% to 2.2%).[24] While coverage for children is normally high, the expansion could have led to a greater willingness to visit the dentist.

Strengths and Limitations

A key strength of the study was the large sample that is representative of urban and Appalachian adolescent male populations of Ohio. The sample was survey-weighted and adjusted during the analysis to represent the target population. Another strength was that we were able to control for many variables that appear to explain some of the association between dental health and urban vs. Appalachian residence.

A limitation of this study is that the participants' dental health status was obtained from the parent-reported survey; a better diagnosis of dental health would come from dental professionals instead of the parent/guardian. Another limitation is that this is cross-

sectional data. Therefore, we are unable to determine whether the outcome or the predictor came first. Regarding the FFQ, this acquired data about food consumption in the previous week. Therefore, the diet in the past week might not be an accurate representation of their diet in the past, which could be what established their poor dental health. While the FFQ is a common way to gather data for food consumption, the suitability could be questioned. There are age-related differences in recall between children 10 to 12 years compared to adolescents over 12 years, and thus adolescents more accurately recall previous foods consumed than children.[20] Finally, data were obtained from the Buckeye Teen Health Study, which focused on smokeless tobacco use among adolescents in Appalachian Ohio, which is more common among boys. Therefore, we were not able to identify possible differences in dental health and behavioral factors between genders. In addition to excluding girls, this also meant that the focus was not on dental health. Thus, there were only a few dental health questions asked and we could not gather a more comprehensive analysis of dental health and dental risk factors in relation to region, such as number of times participants brush and floss per day.

Policy Implications

Tobacco use is a behavioral factor that can account for the poorer dental health among Appalachian adolescent males. With Appalachian adolescents' past 30-day tobacco use being twice that of urban adolescents, this might reflect a cultural difference. Especially in Appalachia, smokeless tobacco use is common among males. In these areas, smokeless tobacco use is considered to be part of the Appalachian identity and masculine, and thus looked at as a rite of passage for many of the adolescent males wanting to gain acceptance in their community.[25]

Multiple cities in Ohio, like Franklin County's Columbus, have adopted a Tobacco 21 law which prohibits all sales of tobacco products and paraphernalia to those under 21 years.[26] While many Ohio localities have adopted this type of law, it has not been adopted statewide, which remains at 18 years. Therefore, adolescents are able to purchase tobacco products from some areas in Ohio. Currently, Ohio Governor Dewine's proposed budget would increase the minimum age to purchase tobacco to 21 years, which would decrease adolescent tobacco purchases in all areas of Ohio, like in the Appalachian areas; however, the current trend has been each locality individually passing the law.

Regarding clinical cessation practices in dentistry, educating Medicaid enrollees and dentists about pharmacotherapy options could increase the number of enrollees in these options. Therefore, our study's findings could help advocate to dentists about limiting adolescent exposure to tobacco products, along with encouraging cessation programs among communities in order to prevent poor adolescent dental health.

Adolescent dental health disparities within Appalachian communities are an Ohio public health problem. The Ohio Department of Health determined that 7 of the 11 counties with poorest dental health were Appalachian. Furthermore, the prevalence of untreated cavities among Appalachian adolescents (27%) is greater than in the rest of Ohio (16%), and 69% higher than urban or suburban areas.[27]

The Ohio Department of Health has dental health care programs to help residents who struggle to access the proper care. Safety net dental programs include public dental clinics, dental programs in schools, and mobile programs, which provide dental care to Medicaid patients and those who cannot afford a private dentist. While this enhances dental health care accessibility, some Appalachian counties do not have these clinics, along

with some requiring the patient to be a resident of the county to receive care.[28] Increased funding directed towards opening more safety net dental clinics in counties in those that do not have would decrease travel obstacles, while also increasing prevention of poor dental health from health professionals who can inform patients.

Conclusions

This study demonstrated that there is some evidence that boys in Appalachia have poorer dental health than those in urban areas. Additionally, some of the disparities in dental health observed between people living in Appalachian and urban areas may be related to behavioral factors like tobacco use and diet. The pattern of results suggests that implementing policies and interventions that target improving behavioral risk factors could potentially reduce the dental health gap between urban and Appalachian adolescents. The policy implications for our results are in the areas of dental access and tobacco prevention and cessation among adolescents, particularly in Appalachia where rates of tobacco use are higher. The findings reported here could provide further evidence that the dental health of adolescents in Appalachian Ohio is poor, which can provide additional calls to action among state health-related agencies in Ohio, local Appalachian governments, and local public health organizations.

Table 1. Distribution of Outcome Variables and Covariates by Region

	Urban (n=)	Appalachia (n=)
Parent-reported dental health		
Excellent to good	93.7% (n=653)	90.3% (n=456)
Fair, poor	6.3% (n=38)	9.7% (n=52)
Dental visits		
Over 1 year ago	8.7% (n=56)	11.0% (n=47)
Within past year	91.3% (n=634)	89.0% (n=461)
Dietary variables		
Total fruit and vegetables**	3.1 ± 0.1	2.6 ± 0.1
Added sugar**	14.6 ± 0.5	18.3 ± 0.6
Sugary beverage**	276.8 ± 13.6	404.6 ± 19.8
Past 30-day tobacco use**		
Not used in 30 days	96.2% (n=675)	92.0% (n=472)
Used in 30 days	3.8% (n=33)	8.0% (n=40)
Age**		
11-13 years	51.3% (n=346)	50.0% (n=256)
14-16 years	48.7% (n=362)	50.0% (n=256)
Race/ethnicity**		
Non-Hispanic White	64.0% (n=456)	91.4% (n=469)
Non-Hispanic Black	22.0% (n=145)	1.6% (n=9)
Other	14.0% (n=107)	7.0% (n=34)
Household Income**		
At or above $50,000	70.0% (n=512)	55.3% (n=279)
Below $50,000	30.0% (n=196)	44.7% (n=233)
Parent education**		
High school or below	10.4% (n=70)	18.9% (n=105)
Some college	29.2% (n=192)	38.7% (n=198)
College or higher	60.4% (n=446)	42.4% (n=209)

*p < 0.05, **p < 0.01

Table 2. Results from logistic regression models predicting fair/poor dental health among adolescent males in urban and Appalachian Ohio

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Region						
Urban	1.0	1.0	1.0	1.0	1.0	1.0
Appalachian	1.61 (0.97-2.67)	1.79 (0.96-3.33)	1.73 (0.93-3.21)	1.74 (0.95-3.19)	1.70 (0.92-3.13)	1.58 (0.86-2.90)
Race/ethnicity						
White		1.0	1.0	1.0	1.0	1.0
Black		2.02 (0.89-4.56)	2.14 (0.95-4.78)	2.09 (0.93-4.70)	2.08 (0.93-4.67)	2.12 (0.95-4.74)
Other		0.79 (0.26-2.41)	0.83 (0.27-2.50)	0.79 (0.26-2.41)	0.79 (0.26-2.39)	0.85 (0.28-2.61)
Household income						
< $50,000		1.0	1.0	1.0	1.0	1.0
≥$50,000		0.66 (0.35-1.23)	0.65 (0.35-1.22)	0.66 (0.35-1.23)	0.67 (0.36-1.25)	0.69 (0.37-1.28)
Past 30-day tobacco use						
No		1.0	1.0	1.0	1.0	1.0
Yes		1.13 (0.40-3.23)	1.05 (0.37-3.01)	1.08 (0.37-3.10)	1.07 (0.37-3.09)	1.00 (0.35-2.88)
Dental visits						
Within year		1.0	1.0	1.0	1.0	1.0
> 1 year ago		1.95 (0.85-4.44)	1.92 (0.83-4.45)	1.90 (0.83-4.35)	1.89 (0.82-4.34)	1.93 (0.83-4.49)
Fruit/veg intake			0.91 (0.82-1.02)			0.89 (0.79-1.00)
Sugary beverage intake				1.00 (1.00-1.01)		
Added sugar intake					1.01 (0.99-1.03)	1.02 (1.00-1.04)

Model 1 is the unadjusted model that includes region only
Model 2 is the model that includes region and controls for race/ethnicity, household income, dental visits in the last year, and any tobacco use
Model 3 includes the variables in model 2 plus fruit and vegetable intake
Model 4 includes the variables in model 2 plus total sugary beverage intake
Model 5 includes the variables in model 2 plus added sugar intake
Model 6 includes the variables in model 2 plus fruit and vegetable intake and added sugar intake

References

1. Imai S, Mansfield CJ. Oral health in north carolina: Relationship with general health and behavioral risk factors. *North Carolina medical journal*. 2015;76(3):142-147. https://www.ncbi.nlm.nih.gov/pubmed/26510215. doi: 10.18043/ncm.76.3.142.

2. Oral health | at A glance reports | publications | chronic disease prevention and health promotion | CDC. https://www.cdc.gov/chronicdisease/resources/publications/aag/oral-health.htm. Updated 2016. Accessed Oct 16, 2018.

3. FastStats. https://www.cdc.gov/nchs/fastats/dental.htm. Updated 2018. Accessed Sep 10, 2018.

4. (DOH), The Division of Oral Health. CDC - children - division of oral health. https://www.cdc.gov/oralhealth/basics/childrens-oral-health/index.html. Updated 2018. Accessed Sep 10, 2018.

5. American Dental Association. Action for dental health:
Bringing disease prevention into communities. . .
https://www.ada.org/~/media/ADA/Public%20Programs/Files/bringing-disease-prevention-to-communities_adh.ashx.

6. Schrimshaw EW, Siegel K, Wolfson NH, Mitchell DA, Kunzel C. Insurance-related barriers to accessing dental care among african american adults with oral health symptoms in

harlem, new york city. *American journal of public health*. 2011;101(8):1420-1428. https://www.ncbi.nlm.nih.gov/pubmed/21680926. doi: 10.2105/AJPH.2010.300076.

7. WHO | sugars intake for adults and children. http://www.who.int/nutrition/publications/guidelines/sugars_intake/en/. Updated 2015. Accessed Oct 16, 2018.

8. Ditmyer M, Demopoulos C, McClain M, Dounis G, Mobley C. The effect of tobacco and marijuana use on dental health status in nevada adolescents: A trend analysis. *J Adolesc Health*. 2013;52(5):641-648. Accessed Sep 12, 2018. doi: 10.1016/j.jadohealth.2012.11.002.

9. Bloom B, Adams PF, Cohen RA, Simile C. Smoking and oral health in dentate adults aged 18-64. *NCHS Data Brief*. 2012(85):1-8. Accessed Oct 16, 2018.

10. Rosema NAM, Timmerman MF, Versteeg PA, van Palenstein Helderman, Wim H., Van der Velden U, Van der Weijden, G. A. Comparison of the use of different modes of mechanical oral hygiene in prevention of plaque and gingivitis. *J Periodontol*. 2008;79(8):1386-1394. https://www.ncbi.nlm.nih.gov/pubmed/18672987. Accessed Nov 14, 2018. doi: 10.1902/jop.2008.070654.

11. Patrick DL, Lee RSY, Nucci M, Grembowski D, Jolles CZ, Milgrom P. Reducing oral health disparities: A focus on social and cultural determinants. *BMC oral health*. 2006;6 Suppl 1(Suppl 1):S4. https://www.ncbi.nlm.nih.gov/pubmed/16934121. doi: 10.1186/1472-6831-6-S1-S4.

12. Byck GR, Walton SM, Cooksey JA. Access to dental care services for medicaid children: Variations by urban/rural categories in illinois. *J Rural Health*. 2002;18(4):512-520. https://www.ncbi.nlm.nih.gov/pubmed/12380894. Accessed Oct 3, 2018.

13. 07 PJ. Medicaid's role in ohio. . 2017. https://www.kff.org/medicaid/fact-sheet/medicaids-role-in-ohio/. Accessed Mar 18, 2019.

14. Squillace J. Assessing the community clinic replacement effect on private medicaid practices in oral health care within rural environments. *J Public Health Dent*. 2013;73(1):18-23. Accessed Sep 11, 2018. doi: 10.1111/jphd.12002.

15. Dodd VJ, Logan H, Brown CD, Calderon A, Catalanotto F. Perceptions of oral health, preventive care, and Care-Seeking behaviors among rural adolescents. *Journal of School Health*. 2014;84(12):802-809. https://onlinelibrary.wiley.com/doi/abs/10.1111/josh.12215. doi: 10.1111/josh.12215.

16. Vargas CM, Ronzio CR, Hayes KL. Oral health status of children and adolescents by rural residence, united states. *The Journal of Rural Health*. 2003;19(3):260-268. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1748-0361.2003.tb00572.x. doi: 10.1111/j.1748-0361.2003.tb00572.x.

17. Heaton LJ, Smith TA, Raybould TP. Factors influencing use of dental services in rural and urban communities: Considerations for practitioners in underserved areas. *J Dent Educ*. 2004;68(10):1081-1089. https://www.ncbi.nlm.nih.gov/pubmed/15466058. Accessed Oct 31, 2018.

18. Wiener RC. Dental fear and delayed dental care in appalachia-west virginia. *Journal of dental hygiene : JDH*. 2015;89(4):274. https://www.ncbi.nlm.nih.gov/pubmed/26304952.

19. Veselicky LT, Sharps G, Veselicky KA. Perceptions of oral health by the WV community. *W V Med J*. 2013;109(6):10-14. Accessed Sep 11, 2018.

20. Cullen, Karen Weber, DrPH, RD|Watson, Kathy, MS|Zakeri, Issa, PhD. Relative reliability and validity of the block kids questionnaire among youth aged 10 to 17 years. *Journal of the American Dietetic Association*. 2008;108(5):862-866. https://www.clinicalkey.es/playcontent/1-s2.0-S0002822308001740. doi: 10.1016/j.jada.2008.02.015.

21. Friedman KL, Roberts ME, Keller-Hamilton B, et al. Attitudes toward tobacco, alcohol, and non-alcoholic beverage advertisement themes among adolescent boys. *Subst Use Misuse*. 2018;53(10):1706-1714. Accessed Jan 29, 2019. doi: 10.1080/10826084.2018.1429473.

22. Substance Abuse and Mental Health Services Administration. Results from the 2017 national survey on drug use and health:
Detailed tables. *Substance Abuse and Mental Health Services Administration*. 2017.

23. Rural and remote health. https://rrh.org.au/. Accessed Mar 18, 2019.

24. Seiber E, Sahr T. Impact of medicaid expansion on potential child enrollment in medicaid. *Ohio Medicaid Assessment Survey*. 2016.

25. Nemeth JM, Liu S-, Klein EG, Ferketich AK, Kwan MP, Wewers ME. Factors influencing smokeless tobacco use in rural ohio appalachia. *J Community Health*. 2012;37(6):1208-1217. https://www.narcis.nl/publication/RecordID/oai:dspace.library.uu.nl:1874%2F278980. doi: 10.1007/s10900-012-9556-x.

26. The City of Columbus. About tobacco 21. https://www.columbus.gov/publichealth/programs/Tobacco-21/About-Tobacco-21/. Updated 2019. Accessed April 3, 2019.

27. Ohio Department of Health. Oral health disparities among children in appalachia ohio https://odh.ohio.gov/wps/wcm/connect/gov/18c9d840-2f78-4153-b9c0-efbf2fd83719/Oral+Health+Status+of+3rd+Grade+Schoolchildren+in+Appalachia+Ohio.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGGIK0N0JO00QO9DDDDM3000-18c9d840-2f78-4153-b9c0-efbf2fd83719-mzCzT7k. Updated 2017.

28. Ohio Department of Health. Patients & the public. https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/oral-health-program/Patients-Public/. Updated 2018. Accessed April 3, 2019.